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Including Technology in the School Curriculum of Developing Countries

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INCLUDING TECHNOLOGY IN THE SCHOOL CURRICULUM OF DEVELOPING COUNTRIES

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This article advocates the introduction of technology as a school subject in third world countries. The justification is that schools can serve to popularize the dispositions that technological culture requires. While the teaching of technology in schools would not lead to economic development, schools can play their part in creating awareness of its possibilities. The article discusses ways in which technology might be introduced, including the science, craft and industrial arts curricula. Lessons from developed countries that are attempting to make the teaching of technology in schools more widespread are discussed.

Cet article recommande l'introduction de la technologie comme un sujet d'étude dans les écoles des pays du Tiers-Monde. L'école est en fait le milieu de propagation des dispositions nécessaires pour une culture technologique. Alors que l'enseignement de la technologie dans les écoles ne mène pas nécessairement au développement économique, les écoles permettent aux gens de se rendre-compte des possibilités de la technologie. L'article présente des moyens d'introduire la technologie au curriculum, comprenant les sciences, les connaissances artisanales et les arts industriels. L'auteur examine également les leçons des pays développés dans leurs efforts d'élargir l'enseignement de la technologie dans les écoles.

INTRODUCTION

Increasingly, developed and newly industrializing countries have been taking steps either to introduce technology as a new subject in their school curricula, or to transform existing subjects (such as craft and design, or industrial arts) that have potential for purveying technological knowledge (see

Department for Education, 1990, for British efforts; Okuya, Miyakawa, Hatano, & Kadowaki, 1993 and Murata & Stern, 1993, for Japanese efforts; and Kim & Land, 1994, for South Korean efforts).

Technology as a school subject remains the object of contestation in the U.S. (Lewis, in press), as advocates continue their attempts to displace industrial arts. Still, the subject is taught on a widespread basis. As Johnson (1992, p.4) points out, "instead of finding students building houses or furniture, one may find them building robots or designing and building communication systems." A recent development is that the scientific community has thrown its weight behind advocacy for the teaching of technology in schools. The American Association for the Advancement of Science (AAAS) commissioned a study which elaborated upon the need for its teaching, and proposed a curricular framework to guide such teaching (Johnson, 1989). The National Science Foundation has funded a research project that seeks to build consensus among U.S. adherents as to what a technology curriculum geared to all students might entail (Dugger, 1995).

For the most part, advocates have tended to conceive of the subject in humanistic terms, that is, as a component of the liberal (or general education) curriculum, and to this end have set forth "technological literacy" as the goal of its teaching (Gagel, 1995; Lewis & Gagel, 1992; Liao, 1994; Salinger, 1994). Technological literacy speaks of an ability to interrogate technology--to be familiar with technological commonplaces and to engage in public discourse on choice and limits. Since literacy implies content knowledge, a challenge for advocates of technology has been to delineate the substance and boundaries of technological knowledge, especially since technology manifests itself in varied ways. It is possible to conceive of it as *artifacts*, such as chop sticks, automobiles, or drill bits; *processes*, such as converting iron ore into steel; or *systems*, such as organizing to mass produce hamburgers. Whatever its manifestations, technology *in its essence* involves the invocation of ingenuity to solve practical problems across all spheres of human existence. The total of the knowledge thereby invoked or learned can be the basis of a realm of technological content.

Increasingly, a second goal--"technological capability" -- is being posited as a reason for teaching the subject. Beyond disposition, this goal speaks of competence, and is particularly evident in the recent British proposals for technology in the senior forms (grades) (see Department for Education, 1990), and in the upper grades of Japanese schools (Murata & Stern, 1993). Suggested as a sample attainment target reflective of "information technology capability" in the new British technology curriculum is the following:

> Develop a system for monitoring the performance of a central heating system in order to plan a system for a house or school . . . (p.49).

A student who can illustrate capability of this order would be able to enter the high-tech sector of the labor market with a saleable skill.

The country stirrings being referred to here are not disconnected episodes. They reflect a trend that has as its impetus the quest to gain competitive edge in the global economy. There is growing belief at official levels in these countries that schools have a role to play in orienting students to the possibilities of technology. Children would thereby become more discerning consumers of technology in their daily lives, more aware of their inventive capabilities, and ultimately more easily adapted members of the labor force upon entry.

This article advocates the introduction of technology as a school subject in the curricula of third world countries, and explores mitigating difficulties that must be taken into account in so doing. While the focus is upon the third world, no claim is to be made here that the introduction of technology leads to or causes economic development. The basic rationale for the teaching of technology is in keeping with a liberal ideal, that is, toward the goal of technological literacy. Though, as the cases of Japan and Britain illustrate, vocationalist possibilities more in keeping with the goal of technological capability are not to be discounted (Caillods, 1984; Enos, 1991).

The case for the introduction of technology to school curricula would hold whatever the stage of development of a particular country. What lends particular credence to a third world focus here is the dearth of advocacy for the teaching of technology in the literature on education for development, and the dismissive way in which the subject is treated when it does find expression in that literature (Lauglo & Narman, 1988). Technology in its various industrial manifestations (manufacturing, construction, transportation, communication, power and energy) is a critical variable in the economic and social transformation of countries.

A contention of this paper is that schools in poor countries must play a crucial role in popularizing its possibilities. To do so, what would be their curricular and instructional options? What conceptual and implementation hurdles can they anticipate? Questions of this order are addressed in the remainder of the paper, which is organized as follows: first, the role of technology in development in third world development is discussed; next follows a discussion of approaches to the introduction of technology to the school curriculum; consideration of lessons to be learned from the experiences of developed countries follows. The paper ends with brief concluding thoughts.

TECHNOLOGY IN THIRD WORLD DEVELOPMENT

All cultures of the world can lay claim to native human ingenuity, and to technological traditions. Whether in the construction of dwellings from indigenous materials, the use of indigenous herbs as medicine, the construction of canoes out of tree trunks, the making of cloth from barks or plants, the making of dyes from plants, bartering, organizing into villages, or making tools and implements out of animal bones, stone, or other locally available materials, technology has manifested itself everywhere, and is indeed a cultural universal. In the poorest countries can be found evidence of human ingenuity, expressed in the artifacts of craftpersons, or in the processes of indigenous industry.

Unlike in rich countries (which can all look back on a time when the technologies that helped fashion their existences were rudimentary), technologies in poor countries have tended to remain tradition bound. The covered wagon was state of the art technology in the opening up of the American west, but has evolved to faster, motorized forms of transport. We do not see this kind of evolution in developing countries. How countries are able to move technology from static to dynamic stages is complex, and beyond the scope of this paper. However, one contributing factor might be the "scientization" of technology (Habermas, 1971). According to Habermas, though technology has progressed through time on its own terms, in the twentieth century, in the service of capitalism, it has been brought under the influence of science, in research and development centers. Beyond the infusion of scientific principles, there is the added ingredient of organization (and of course sponsorship).

Most third world countries are unable to move the development of local technology from fortuitous, spontaneously occurring realms to the scientized realm of which Habermas speaks. As part of their modernization efforts, these countries simply import technologies. But when such importation is at the expense of local ingenuity, it could give rise to the condition of dependence. A lesson from the NICs (Newly Industrializing Countries) though is that the third world does not have to be perpetually dependent. Countries once considered to be at the periphery of the developed capitalist countries (e.g., Brazil, Mexico, Taiwan, India, Singapore, Korea) have changed their fortunes by finding ways to employ modern technology as a catalyst for economic transformation. Far from viewing technology from the posture of a passive consumer, they have changed the psychology, becoming exporters of state-of-the-art industrial products (e.g. Chichilnisky & Heal, 1986; Sewell & Tucker, 1988).

Fong (1986) argues that technology has been crucial in the on-going efforts of Malaysia to attain the status of an advanced NIC. He reasons thus:

> it is clear that for a relatively small (though resource rich) country such as Malaysia to be successful in its export-oriented industrialization efforts, far greater attention ought to be given to the role that technology plays in determining the competitiveness of its industries. Only by encouraging technology and techniques that reflect its various resource endowments ... can the country aspire to produce industrial goods efficiently and competitively and hence have a far better chance of capturing the world market even in the face of protectionist policies. (p. 7)

To Fong, technology is "the mastery and utilization of manufacturing and industrial methods" (p. 14). For Malaysia to make a technological leap forward he sees the need for state policy on technology.

Looking more generally at the third world, Bhagavan (1990), like Fong (1986) agrees that the technological level of the manufacturing industry is the best indicator of the technological situation in such countries. Bhagavan compartmentalizes technology into equipment and knowledge components. He argues that third world countries can be differentiated and categorized according to the way in which "they are meeting their current demand for *standard modern technology*, that is, technology which has medium to high values in the degrees of automation, science-relatedness and research intensity" (p. 27). On this basis he sets forth four categories, namely (a) countries that are technologically highly self-reliant (e.g., Brazil, China, India, South Korea), (b) those that are technologically nearly self-reliant, (e.g., Argentina, Malaysia and Mexico), (c) technologically partly-self reliant (Indonesia, Venezuela, Iran), and (d) technologically dependent countries (e.g., Bangladesh, Jamaica, and Nigeria) (p. 27). Like Fong, Bhagavan too calls for policies in the developing countries that will further the advance of technology. In particular, he suggests that ways be found to make technology the possession of not just a narrow band of elites, but of the masses. Bhagavan does not explicitly articulate the teaching of technology as a school subject. But schools can play an important role here, in demystifying technology, and in shaping critical consciousness as to its role.

Enos (1991) urges poor countries to strive toward technological capability, which, he argues, requires three ingredients, (a) trained talented individuals, (b) institutions in which such individuals can be assembled, and (c) a common purpose. There is a degree of concurrence here with Habermas (1971). In developed countries, the "institutions" of which he speaks would be universities, or research and development centers, sponsored either by the state or by the private sector. Enos argues that it is necessary to have policy that specifically seeks to nurture technical skills. He envisages a role in this for education, thus:

> It should go without saying that the prerequisite of a technologically competent nation is a universally schooled population. The basic education enabling mastery in the use of traditional technologies consists of the ability to read and write, to carry out arithmetical calculations and to comprehend and apply scientific method. (p. 121)

He goes on to say that the provision of universal primary education of itself will not ensure the provision of basic technical skills since "there is not enough mathematics and technology in the curricula of most developing countries." The primary reason for this shortcoming, he suggests, is that "the teachers are not adequately trained and tempered" (p. 124). Enos concedes the dearth of technology in the school curriculum, but he does not overtly advocate its inclusion.

King (1984) cited absence of opportunity for informal learning (about technology) as a barrier to the development of indigenous technical capability in Africa. He argued that the "technological environment in which young people are nurtured" is critical to the development of capability. Noted King:

> But what is clear about the informal learning environment of many homes and villages in Africa is how very little there is in the way of technical clutter to stimulate children . . . (p. 42)

King's observation provides a strong argument for the introduction of technology into the curriculum of third world countries. If the home, and the wider society, cannot provide the learning environment of which he speaks, it is then left to the school to do so.

But to say that schools have a role to play here is not to deny that, as in developed countries, technological studies are of low status in poor countries. Caillods (1984) suggested that a reason for this low status has been the tendency to exclude such studies from the academic stream, and to offer them only to those in the low ability technical stream. His solution was to offer technology (integrated with science) to both streams. Technology would thus become available to all--no different from other liberal education subjects in the curriculum. Noted Caillods:

> In other words, all students should be given a good scientific and technological culture, and the same one, no matter what specialisation they may opt for afterwards. (p. 220)

As indicated above, many countries are taking practical steps to arrive at just this ideal.

The above discussion provides some tentative generalizations regarding the perceived role of technology in third world development, and a possible role for schools, as follows: (a) there is correlation between stage of development and degree of technological capability, (b) such capability depends in fair measure on the capacity of countries to absorb technology, and (c) that capacity to absorb technology depends on the store of general literacy, inclusive of technological literacy.

While there could be little disagreement that education and the technological capability of a country are linked, the notion that technology should be a part of the general curriculum is not easily internalized. In some measure, this is due to the fact that little is known about the teaching of technology, which is a relatively new claimant as a school subject. Philosophical and other issues that attend its teaching are still being contested. Technological knowledge is unlike traditional school knowledge; its case still needs to be argued. In the next section of the article, alternative approaches to the introduction of technology into the school curriculum are explored, drawing in fair measure upon third world examples.

APPROACHES TO THE INTRODUCTION OF TECHNOLOGY

Three general tendencies emerge from the literature suggestive of ways in which technology can be introduced into the curriculum of third world schools, namely (a) within science, (b) through crafts, and (c) as technology education, with industry being the context. Each of these approaches is now examined, focussing where possible, but not exclusively, on third-world based literature.

Technology in the Science Curriculum

When proposed as a part of the science curriculum, technology invariably is set forth as a sub-set of science. Typical of this approach is the position taken by Caillods (1984), that technology should be taught not as a separate subject, but integrated with physics or mathematics. The latter two subjects would have their own individual identities in the school, but technology would have conditional identity. Rugumayo (1987) expressed the view that the purpose of science is "to understand nature in order to change it" (p. 83). Thus, he would have the science curriculum reflect not just the world of the pure scientist, but that of the engineer and technologist as well.

Dreyfus (1992) defines a technology oriented science curriculum as one which "teaches a scientific discipline in a technological context . . . Fundamental knowledge is presented in the context of its technological applications." The author makes clear that "The essential purpose is to teach science, and not to emphasize technicalities" (p.3). This latter point provides the major argument against introducing technology to the curriculum in this way. Technology tends to be marginalized (see Layton, 1988, for a discussion of this problem).

Krugly-Smolska (1990) advocates that the science curriculum of developing countries should be designed to foster scientific literacy. The goal of the science curriculum should be to ensure personal development through personal decision making. In the context of developing countries, where "technological decisions are at present in the hands of a few" (p. 474) the aim would be to foster a climate of public opinion that would lead to "better use of science and technology in industrial development" (p. 474).

In similar vein, Jegede (1988) advocated the Science/Technology/Society (STS) curricular approach in Nigeria. His rationale for STS includes the following:

> The need to address the issue of the place of technology in a developing country. It is observed that although very little technology is practised, the influence of the imported technology on the populace is enormous. Even the remotest settlements come in contact daily with the products of modern western technology in one form or another, either through the use of radios, trucks, medicines, chemical fertilizers or other essentials. The copious consumption of the imported products of science and technology in an environment devoid of an established scientific culture calls for a remediation through information" (p. 401)

What Jegede speaks of here is the problem of dependence, a condition whose antidote is self-reliance. The STS approach allows the kind of interrogation that can reveal connection between technological literacy, technological capability, and self-reliance.

Nganunu (1988) reported on the inclusion of technology topics in the context of science teaching in Botswana. Topics were chosen so that they were relevant to current needs of the country, and so that students would thereby become aware that they must be "adaptable to new technological developments that may change our way of life" (p. 445). "Relevance to current needs" is a worthy ideal, but current needs might be modest. Technology has to instill a sense of *possibilities.*

In discussing the problem of creating capacity for technological innovation in Kenya, Eisemon (1989) speaks of linkage between schooling effects and cognition. He agrees that schooling effects cannot be independent of content. He appears, implicitly, to leave open a role for the purveyance of technological principles through science.

Other things being equal, technology through the science curriculum would be a satisfactory conception, and a way to introduce technology into the curriculum of third world schools. Russell (1972) distinguished between *theoretical science*--understanding the world, and *practical science*--changing the world (p. 492), saw no hierarchy here. Practical science was science. It was technology. In modern thinking though, there is a hierarchy, along pure and applied lines. Technology is viewed as applied science. Being applied, it is accorded lesser epistemological stature than pure science. Downey, Donovan & Elliot (1989) dwell on this problem in their discussion of sociological difficulties that have bedevilled the field of engineering.

To deem technology to be applied science is to diminish its standing as a valid realm of knowledge. Thus, conceptions that propose its teaching in the context of science, while well meaning, run the risk of marginalizing technology (Dreyfus, 1992).

In one field-based report, Jones and Kirk (1990) set forth to establish links in the curriculum between physics and its technological applications. The curriculum worked forward from physics concepts to applications that will serve to enhance the learning of physics. But technology does not work that way. It is not an incidental that is happened upon in the quest for scientific truth. Technology proceeds forward from an existential problem, or from creative or intellectual urges. Related science becomes contingent. Technology, indeed, is not bounded by nature. It requires its own mode of thinking--its own rules of inquiry (Rapp, 1989; Skolimowski, 1972).

Difficulties such as these have been sharply set forth by Layton (1988) in his critique of STS. Layton supports STS, but calls for epistemological equality between science and technology. In like vein, important contributions to the discourse have been provided by Chen and Novik (1984) and Raat and de Vries (1987).

If technology is to be introduced into the curriculum of third world countries via the science curriculum, the issue of its epistemologic integrity needs to be borne in mind. The subject must first exist in its own right, like physics or mathematics, before it can be integrated with these subjects.

Craft as Technology

Deviating from the notion that technology in the curriculum is essentially for general education purposes, there have been suggestions in the literature that craft technologies ought to be taught to foster self reliance through earning capability. Nwana (1987) set forth that an aim of the teaching of small scale industry and technology in the curriculum of Junior secondary schools in Nigeria was to provide students with entrepreneurial skills that could lead to self-help through job creation. In similar vein, Eisemon, Ong'esa and Hart

(1988) proposed the teaching of craft skills to elementary school students in Kenya. Technology can indeed be taught through craft, consistent with the ideal of technological capability. Self-reliance is a noble aim of such teaching in third world contexts. But the teaching of technology ought not to be needlessly constrained by tradition, though that would be an important part of the pedagogy, if only to awaken students to their own indigenous possibilities. Along with traditional craft technologies, children would have to be introduced to the modern world--to lasers and satellite technology--to micro-chips.

Technology education (industry as context)

Most countries that are actively seeking to introduce technology into schools are not installing a brand new subject, but rather, are transforming existing industry based ones, notably industrial arts, (United States, Republic of Korea, Japan), and Craft/Design/Technology (Great Britain), a subject that itself represented a transformation of industrial arts. The term "arts," when used in the context of industry, is essentially the linguistic equal of technology. Thus, industrial arts classes really should present opportunities for learning about technology. However, industrial arts throughout the world had become tradition bound, offering woodworking, metalworking and drafting skills, to the exclusion of a bigger picture of the range of industrial technologies.

When the subject is recast to reflect technology, new content organizers emerge, notably manufacturing, communication, transportation, construction, and power and energy. Problem-solving becomes a primary pedagogic strategy, as instruction becomes more open-ended. The context (social, economic, political) of technology is now taken into account, allowing environmental, conservation, safety, and other such issues to inform the curriculum (see Warner, 1965; Savage & Sterry, 1990a; 1990b; and Department for Education, 1990 for comprehensive curricular frameworks, and scope and sequence models).

As indicated earlier, this shift from industrial arts to technology education has occupied a significant amount of the time of American advocates in the last decade. For many, more than content reform, it has become a question of status in the curriculum. Adoption of technology is seen as making the field more respectable, relieving it of the stigmas wrought by industrial arts (see a discussion of the sociology of change efforts in Lewis, 1994).

It is interesting here, that while in the United States traditional industrial arts teaching has been viewed as anachronistic, and not consistent with the broader goals of technology teaching, in Japan industrial arts thrives. Industrial arts staples (tool skills, constructing, designing, blueprint reading, measuring, drafting, finishing, quality, pride in work, basic electricity, etc) are at the core of the compulsory technology curriculum. The lesson here is that to teach technology a country does not have to discard all of its existing industrial arts infrastructure. What is needed is re-casting of industrial arts, including reorienting of the teachers.

Teaching technology in the context of industry seems an attractive prospect for third world countries, since many have industrial arts teaching traditions in their schools. Osunde (1988) described an approach in which technology was to be taught in the context of a diversified secondary school curriculum. "Introductory Technology" would be taught as a pre-vocational subject, to provide "(a) orientation to the technology used in modern vocations; (b) basic technological literacy for every day living" (p. 38).

Lauglo and Narman (1988) reported the teaching of industrial education in academic schools in Kenya, as part of that country's curricular diversification efforts. The content areas included wood technology, metal technology, power mechanics, and electrical technology. These authors were not convinced that the teaching of this content could be justified on cost-benefit terms. Applying efficiency criteria only, much like Foster (1965) did in his evaluation of industrial education curricula in Ghana, and ignoring the myriad other qualitative factors that explain why a third world country would wish its children to become schooled in this form of knowledge, they questioned the efficacy of the investment.

This kind of almost instinctual efficiency-minded response to third world initiatives of this order now needs to be re-examined, in light of the dictates of a global economy, and the transformational possibilities that many countries now see as they look at industrial arts. Critics who raise the issue of costs would at least have to broaden their view of benefits, which are not all easily quantifiable.

Industry-settings

Industry itself can become an extension of the school in the teaching of technology. Tanuputra (1987) has set forth how the tea industry in Indonesia became a focus of the technology curriculum there. A visit to a tea factory became the trigger for a set of activities leading to an understanding of technology. Students were exposed to production, manufacturing and transportation processes. Yakubu (1987) discussed a case study curricular approach in Ghana in which students were required to study local industries, and to identify underlying scientific and technological concepts. Holbrook (1987) discussed ways in which technology education was conceived and taught in Pakistan. While not demanding elaborate workshops, the objectives of the program included the following:

to encourage students to explore and experiment and to express individual creativity . . . to impart to students a knowledge of basic materials, processes and techniques in terms of their usefulness in everyday life, to develop in students a proficiency in the use of elementary hand-tools and equipment, to develop in students an appreciation for the cost of materials in order to reduce unnecessary wastage...(p. 86)

These above cases point to the fact that the community is the laboratory for the teaching of technology. Schools may work in partnership with firms.

While the teaching of technology in the context of industry produces a curriculum that is thus circumscribed, concerns over narrowness can be countered by the fact that industry has legitimate claims as being the primary contemporary incubator of technology (e.g. Habermas, 1971). The appeal of this approach for third world settings is that it would not require wholesale change where there have been industrial arts traditions.

Reflection:

Which approach to the teaching of technology in the third world bears more promise is debatable, and perhaps an issue to be postponed given the fledgling nature of the idea of technology in the curriculum. Science, industry, and craft are all valid claimants as ways to purvey the subject. Each has particular strengths.

Having explored possible ways in which technology might be introduced to the school curriculum of developing countries, it is left to point out that introducing technology presents many challenges. Some of these challenges will derive peculiarly from the third world condition--of absence of resources, absence of industry, shortage of trained teachers, and so on. Others may be of more universal nature. These can be anticipated, if lessons learned by other countries are reflected upon. The next section of the paper examines the experience of selected developed countries for lessons that might be relevant in the developing world.

LESSONS FROM DEVELOPED COUNTRIES

One examines foreign educational models to learn *from* and *about* them. This brief review of the experiences of selected developed countries (Sweden, Britain, the Netherlands, the United States, and Japan) assumes both these postures. A first general lesson to be learned from these countries is that including technology in the school curriculum is fraught with curricular and other practical difficulties (see a discussion in Lewis, 1991). As a school subject, technology is an outlier, on the counts of being new and unfamiliar, and not conforming to a traditional conception of valid knowledge (Lewis, 1993). In Sweden, attempts to introduce the subject in the primary school suffered because "little was known about contents and methods for this new subject" (Lindblad, 1990, p.167). As such, the question of content remained implicit, and the methods problem was dealt with by allowing students to learn traditional crafts in an exploratory way.

In Britain, likewise, attempts to teach technology prior to its being included in the National Curriculum found best expression in the laboratories of Craft/Design/Technology (CDT) teachers. Allsop (1987) pointed out that U.K. science teachers were not always eager to introduce technology into their teaching. Beyond the pressures of examination requirements at the upper level of the school, such teachers were not as accommodating of the open ended, risk-taking nature of the problem-solving method of technology as were CDT teachers. Similar observations are set forth in Allsop and Woolnough (1990). As the subject regressed toward its craft traditions, it tended to retain its boys-only gender bias (Nash, Allsop, and Woolnough, 1984).

As in Britain and Sweden, regression to the craft tradition of industrial arts has been a major hurdle for the subject in the United States (Lewis, in press). In their annual survey of the status of technology education in American schools, Dugger, French, Peckham and Starkweather (1992) found that traditional arts subjects such as woodworking, drafting, and general metals still were dominant in junior, middle and senior high schools.

Country comparisons reveal interesting variations in approach to representation of the subject in the curriculum. In America, the dominant ethic has been industrial culture, with emphasis on broad themes (e.g. construction, transportation, and energy), and on problem solving. In Britain, technology in the National Curriculum ranges well beyond industry. The guiding curricular theme is "design and technological capability." Curricular organizers in keeping with this theme include "identifying needs and opportunities," "generating a design," "planning and making," and "evaluating." A sample goal taken from the curriculum is the following:

> Pupils should be able to identify and state clearly needs and opportunities for design and technological activities through investigation of the contexts of home, school, recreation, community, business and industry. (p. 3)

In Japan, as indicated above, an intriguing aspect of the new technology curriculum is that it explicitly includes woodworking. To do so in the American technology curriculum today would be perceived as retrogressive. But woodworking does not always have to mean mere craft. One goal of its teaching in the Japanese curriculum is "to be able to assemble adequately the following: the idea, the sketch, and the plan for production" (Okuya et al., 1993, p.26). This goal clearly intends emphasis on an understanding of manufacturing. More obviously reflective of the times, the Japanese curriculum includes study of information technology, with goals such as knowing the operation of a computer, the function of software, and how to make a simple program.

In the Netherlands there has been an upsurge of interest in technology as a school subject. Technology became a school subject in its own right in lower secondary education in 1992 (DeVries, 1991). Prior to this it was not included in the general education curriculum, but rather as a subject known as "general techniques" in the technical-vocational curriculum (Raat and DeVries, 1987). Two interesting aspects of that country's experience have been emphasis on technology teacher education (six of the country's teacher training institutes started technology teacher education programs in 1989), and a focus on research, notably a program of inquiry into student attitudes to technology (see for example Streumer and Doornekamp, 1989). Emphasis on teacher preparation provides clarity regarding who should teach the subject, as well as on the nature of the content that should be taught.

Reflection

Beyond lessons relating to philosophical, conceptual or implementation difficulties, third world educational policy makers should come to see that on a fairly widespread basis in the developed world, the subject is being allowed to incubate. It ought to be instructive that, difficulties notwithstanding, the subject has a home in the major industrial centers of North America, Europe and Asia (and in New Zealand and Australia (see Jones & Carr, 1992; Rennie, 1987; and Rennie, Treagust, and Kinnear, 1992). How (or why) is the experience of these countries relevant to the third world? A simple answer here seems to be that if technology is deemed to be important enough to be included in the curriculum of technology rich countries, then the case for its inclusion in that of technology poor (by contemporary standards) countries ought to be half as easy to argue. In developed countries the school is but one means via which technological literacy can be fostered. There is the home, industry, museums, farms, and so on. There is, borrowing from King (1984), much "technical clutter" to stimulate children. In many third world countries the school may well be the *only* viable means. The introduction of the subject in schools might be viewed as an expensive proposition. But it does not have to be that way. Technology can be taught inexpensively. For example, students in a third world technology class could be asked to design and make bricks out of different combinations of soil, sand, straw, etc. These bricks could be tested for strength. Cost would be modest. Or, they could be made to design solar heating systems. A popular project in the U.S. is the egg-drop problem. Students must design a package that will protect an egg from a fall from a height. Material use and laboratory requirements are modest, but the design lessons learned are powerful.

But even if the subject were an expensive proposition, it would seem to be an easily justifiable target of foreign aid, because of the potential for arousing capacity-enhancing behaviors such as self-reliance, curiosity, and inventiveness. What third world educational planners and policy-makers should understand at least, is that establishing the subject calls as much for money and equipment as for imagination.

CONCLUSION

It has been suggested here that technology should find a place in the curriculum of third world schools, primarily toward the end of technological literacy, but not dismissing the possibility that an end might be technological capability. No claim has been made here that a causal link between the teaching of technology and economic development exists. What has been argued however, is that schools are a logical place for third world countries to popularize technology's essence and possibilities. Given the upsurge of interest in the subject worldwide, this case is more easily made now than before.

References

Allsop, R. T. (1987). Factors affecting the uptake of technology in schools. In D.J. Waddington (Ed.) *Education, Industry and Technology*, New York: Pergamon Press.

Allsop, T., and Woolnough, B. (1990). The relationship of technology to science in English schools. *Journal of Curriculum Studies, 22*(2), 126-136.

Bhagavan, M. R. (1990). *The technological transformation of the third world.* London: Zed Books Ltd.

Caillods, F. (1984) Education, organization of work and indigenous technological capacity. In *Technological capability in the Third World*, (edited by M. Fransman, and K. King), p.211-222. New York: St. Martin's Press.

Chen, D., and Novik, R. (1984). Scientific and technological education in an information society. *Science Education, 68*(4), 421-426.

Chichilnisky, G. & Heal, G. (1986). *The evolving international economy,* Cambridge, England: Cambridge University Press.

Department for Education. (1990). *Technology in the national curriculum.* London: HMSO, Central Office of Information.

Downey, G.L., Donovan, A., Elliot, T.J. (1989). The invisible engineer: How engineering ceased to be a problem in science and technology studies. In L.Hargens, R.A, Jones, & A. Pickering (Eds.), *Knowledge and Society: Studies in the sociology of science past and present, 8*, 189-216, Greenwich, CT: JAI Press.

Dugger, W.E. (Jr.). (1995). Technology for all Americans. *The Technology Teacher, 54*(5), 3-7.

Dugger, W.E. (Jr.), French, B. J., Peckham, S., and Starkweather, K. N. (1992). Seventh annual survey of the profession 1990-1991. *The Technology Teacher, 51*(4), 13-16.

DeVries, M.J. (1991). What do students in Dutch Technology Teacher Programmes think of their subject? *Research in Science & Technological Education, 9* (2), 173-179.

Dreyfus, A. (1992). Content analysis of school textbooks: the case of technology-oriented curriculum. *International Journal of Science Education, 14*(1), 3-12.

Eisemon, T. O. (1989). Schooling, cognition and creating capacity for technological innovation in Africa. *International Review of Education, 35*(3), 329-348.

Eisemon, T. O., Ong'Esa E., and Hart, L. (1988). Schooling for self employment in Kenya: The acquisition of craft skills in and outside schools. *International Journal of Educational Development, 8*(4), 271-278.

Enos, J. L. (1991). *The creation of technological capability in developing countries.* New York: Pinter Publishers.

Fong, C. O. (1986). *Technological leap: Malaysian industry in transition.* Oxford: Oxford University Press.

Foster, P. J. (1965). The vocational school fallacy in development planning. In C.A. Anderson et al. (Eds.) *Education and Economic Development.* Chicago: Aldine.

Gagel, C.W. (1995). *Technological literacy:a critical exposition and interpretation for the study of technology in the general curriculum,* Unpublished Ph.D. Dissertation, University of Minnesota.

Habermas, J. (1971). *Toward a rationale society.* London, Heinemann Educational Books.

Holbrook, J. B. (1987). Technology education: A union of science and technical skills. In D.J. Waddington (Ed.) *Education, Industry and Technology.* New York :Pergamon Press.

Jegede, O. J. (1988). The development of the science, technology and society curricula in Nigeria. *International Journal of Science Education, 10*(4), 399-408.

Johnson, J. R. (1989). *Technology. Report of the Project 2061 phase I technology panel.* Washington, DC: American Association for the Advancement of Science.

Johnson, J.R. (1992). Technology education an imperative. *The Technology Teacher. 52*(2), 3-5.

Jones, A. T., and Kirk, C. M. (1990). Introducing technological applications into the physics classroom: Help or hindrance. *International Journal of Science Education, 12*(5), 481-490.

Jones, A. & Carr, M. (1992). *Teachers perceptions of technology education.* Working paper 502. Hamilton, New Zealand: Centre for science and mathematics education research, University of Waikato.

Kim, C. & Land, M.H. (1994). Recent development of technology education in Korea, *The Technology Teacher, 53*(4), 30-33.

King, K. (1984). Science, technology and education in the development of indigenous technological capability. In M. Fransman and K. King (Eds.) *Technological Capability in the Third World.* New York: St. Martin's Press, pp. 31-63.

Krugly-Smolska, E. T. (1990). Scientific literacy in the developed and developing countries. *International Journal of Science Education, 12*(5), 473-480.

Lauglo, J., and Narman, A. (1988). Diversified secondary education in Kenya: The status of practical subjects and their uses after school. In J. Lauglo and K. Killis (Eds.) *Vocationalizing Education: An International Perspective.* pp. 235-256. New York: Pergamon Press.

Layton, D. (1988). Revaluing the T in STS. *International Journal of Science Education, 10*(4), 367-378.

Lewis, T. (1991). Introducing technology into school curricula. *Journal of Curriculum Studies, 23*(2), 141-154.

Lewis, T., and Gagel, C. (1992). Technological literacy--A critical analysis. *Journal of Curriculum Studies, 24*(2), 117-138.

Lewis, T. (1993). Valid knowledge and the problem of practical arts education. *Curriculum Inquiry, 23*(2), 175-202.

Lewis, T.L. (In Press). From manual training to technology education: the continuing struggle to establish a school subject in the USA. *Journal of Curriculum Studies.*

Lewis, T. (1994). Limits on change to the technology education curriculum. *Journal of Industrial Teacher Education. 31*(2), 8-27.

Liao, T.T., (1994). Toward technological literacy for all. *The Technology Teacher, 54*(3), 2-4.

Lindblad, S. (1990). From technology to craft: on teachers' experimental adoption of technology as a new subject in the Swedish primary school. *Journal of Curriculum Studies. 22*(2), 165-175.

Murata, S., & Stern, S. (1993). Technology education in Japan. *Journal of Technology Education, 5*(1), 29-37.

Nash, M., Allsop, T., & Woolnough, B. (1984). Factors affecting the uptake of technology at 14+, *Research in Science and Technological Education, 2*(1), 5-19.

Nganunu, M. (1988). An attempt to write a science curriculum with social relevance for Botswana. *International Journal of Science Education, 10*(4), 441-448.

Nwana, O. C. (1987). The place of small-scale industry and technology in the curriculum of junior secondary schools in developing Africa: The case of Nigeria. In D.J. Waddington (ed.) *Education, Industry and Technology*. New York: Pergamon Press.

Okuya, T., Miyakawa, H., Hatano, Y., Kadowaki, T. (1993). The new National Curriculum of technology education in Japan. *The Technology Teacher, 53*(2), 24-27.

Osunde, E. (1988). Diversifying the secondary school curriculum in Nigeria: Problems and policy options. *Canadian and International Education, 17*(1), 36-44.

Raat, J. H., and de Vries, M. (1987). Technology in education: Research and development in the project *'Physics and Technology'*. *International Journal of Science Education, 9*(2), 159-168.

Rapp, F. (1989). General perspective on the complexity of philosophy of technology. In Paul T. Durbin (ed), *Philosophy of Technology*. (Holland: D. Reidel, ix-xxiv.

Rennie, L.J. (1987). Teachers' and pupils' perceptions of technology and the implications for curriculum. *Research in Science & Technological Education. 5*(2), 121-133.

Rennie, L.J., Treagust, D.F., & Kinnear, A. (1992). An evaluation of curriculum materials for teaching technology as a design process. *Research in Science & Technological Education. 10*(2), 203-217.

Rugumayo, E. B. (1987). Science education and the needs of developing countries. In J.L. Lewis and P.J. Kelly (Eds.) *Science and Technology Education and Future Human Needs*, pp. 81-87. New York: Pergamon Press.

Russell, B. (1972). *A history of western philosophy*. Simon and Schuster, New York.

Salinger, G. (1994). Educational reform movements and technology education. *The Technology Teacher, 53*(5), 6-8.

Savage, E, & Sterry, L. (1990a). A conceptual framework for technology education, part 1. *The technology teacher,50*(2), 7-11.

Savage, E. & Sterry, L. (1990b). A conceptual framework for technology education, part 2. *The technology teacher, 50*(2) 7-11.

Sewell, J.W. & Tucker, S.K. (1988). Swamped by debt: U.S. trade with the NICs. In T.F. Bradshaw, D.F. Burton Jr., R.N. Cooper, & R.D. Hormats (Eds.), *America's new competitors: The challenge of the newly industrializing countries.* (pp.179-202). Cambridge, MA:Ballinger.

Skolimowski, H.(1972). The structure of thinking in technology. In C. Mitcham and R, Mackey (Eds.). *Philosophy and Technology: Readings in the philosophical problems of technology,* New York:Free Press.

Streumer, J.N. & Doornecamp, G. (1989). Technology assessment study in The Netherlands. *Research in Science & Technological Education, 7*(2), 191-205.

Tanuputra, G. (1987). A case study from Indonesia. In D.J. Waddinton (Ed.) *Education, Industry and Technology.* Pergamon Press, New York.

Warner, W.E. (1965). *A curriculum to reflect technology.* Columbus, Ohio: Epsilon Pi Tau Inc.

Yakubu, J. M. (1987). The science in Ghanaian society project. In D.J. Waddington (ed.) *Education, Industry and Technology.* New York: Pergamon Press.